

Djibouti Ville Drift (SW Mediterranean): Sedimentation and record of bottom-current fluctuations during the Pleistocene and Holocene

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Abstract: Seismic profiles and sedimentological data (bulk fraction) of two sediment cores recovered from the Djibouti Ville Drift (SW Mediterranean Sea) indicate that bottom currents have played a fundamental role in shaping the sediment drift. The deposits are composed of biogenous to mixed muddy and silty contourites. A grain size analysis of the terrigenous fraction together with mineralogical, magnetic susceptibility, ¹⁴C-AMS dating and stable oxygen isotope data have been analysed to reconstruct glacial and interglacial changes in the bottom currents during the last 133kyr. The sharp vertical grain size changes in the moat and drift indicate that there were substantial bottom current acceleration and deceleration events with faster flow speeds being registered in the moat environment. In sediments from glacial periods (MIS2, MIS3, and MIS6) and stadials 5b and 5d, there is a low carbonate content, high levels of terrigenous elements and paleocurrent proxy values suggest faster flows with the exception of MIS4. Deposits from the interglacial period (MIS1) and interstadials 5a, 5c and 5e, have a high carbonate content, low levels of terrigenous elements, and the paleocurrent proxy values indicate slower flows.

Key words: drift and moat deposits, sortable silt, paleocurrents, seamount, Alboran.

INTRODUCTION

The southern sector of the Djibouti Ville Seamount is characterized by the presence of a drift contourite system between 700 and 1075m water depth. This seamount is located on the Motril Marginal Plateau in the South Iberian Margin (Northern Alboran Sea) (Palomino et al., 2011). The contourite system comprises a small elongated separated drift associated to a moat (Fig 1). The Alboran Sea is characterized by three main water masses (Millot, 1999): Atlantic Water-AW (0-200m), Levantine Intermediate Water-LIW (200-600m) and Western Mediterranean Deep Water-WMDW (>600m). The present-day general circulation shows that the drift contourite system is swept by the WMDW although one CTD deployed in summer 2012, registered that it was affected by the interphase zone between LIW and WMDW (Juan pers. comm.). The aims of this paper are to examine the sedimentary dynamic and the glacial to interglacial changes in bottom currents across the drift contourite system.

Two cores (up to 6m long) were recovered from two sedimentary environments, the moat (core PC15, 763m water depth) and the drift (core K3, 712m water depth). They are separated by only 1.5km. The following analyses were carried out on the cores: a) on the bulk fraction: grain size analysis, scanning XRF-derived

elemental data and magnetic susceptibility (MS); b) on the terrigenous fraction: grain size analyses (sortable silt, mean and silt/clay ratio) as proxies for bottom current intensity (Hall and McCave, 2000); c) on discrete samples: ¹⁴C-AMS data. Additionally, stable isotope $\delta^{18}\text{O}$ measurements were carried out on the planktonic foraminifera *G. bulloides* in core K3.

RESULTS

The stratigraphic data for core K3 shows that the core spans the past 133kyr. Glacial stages, stadials (5b and 5d), interglacial stages (Holocene) and interstadials (5a, 5c and 5e) can be recognized (Fig. 1A). These stages clearly correlate with the isotope curve for the Alboran Sea (Martrat et al., 2004). The carbonate content is higher (40-49%) in interglacial periods, whereas the sedimentation rate is higher (up to 7.3cm.kyr⁻¹) in the glacial periods, with a general mean value of 4cm.kyr⁻¹ (Fig. 1A). The $\delta^{18}\text{O}$ stratigraphy for core PC15 is not available; the mean sedimentation rate is 3.8cm.kyr⁻¹ based on ¹⁴C-AMS data.

Both cores have a similar sedimentation rate and there is an absence of lag deposits and hiatuses. Comparing the two cores therefore allows a correlation of the lithological units in the drift-moat system (Fig. 1). Sediment core analysis (MS, Ti, Si, Sr, Ca curves)

provides evidence of an along slope trend of six main correlatable sedimentary units (a to f) (Fig. 1B and D). These units are composed of three main types of contourite facies: 1) homogeneous mud (< 8 μ m mean), 2) thin-bedded fine silt (8-14 μ m mean) and 3) mottled silty mud (14-20 μ m mean). The vertical trends of mean terrigenous grain size display maximum peaks which are coincident with the maximum values of the sortable silt (SS) and the silt/clay ratio (S/C)(Fig. 1). The values of these peaks vary between the moat and drift environments. The peaks in the moat are characterized by a coarser grain size (up to 19 μ m mean, 68% SS, 9 S/C) than in the drift (up to 10 μ m mean, 48% SS, and 3.7 S/C).

SEDIMENTARY DYNAMICS AND PALEO-CURRENT EVENTS FROM THE PLEISTOCENE TO HOLOCENE

In the Drift Contourite System. The development of the Djibouti Ville Drift is conditioned by the efficiency of deep water circulation in the area in reworking, winnowing, transporting and accumulating terrigenous and biogenous particles. The spatial distribution of the sedimentary facies reveals that muddy and silty contourites characterize both environments (moat and drift) (Fig. 1). The sharp vertical variations in paleocurrent proxies suggest fluctuations in the intensity of bottom currents in both environments. The maximum and minimum values are interpreted as acceleration followed by deceleration of bottom currents, respectively. The moat registers faster flow speeds than the drift, and it displays a wider range of grain size proxy values. This can be seen most clearly in sedimentary unit c (Fig. 1B, D). Between the moat and drift in this unit there is a large and abrupt increase in the sortable silt (from 43 to 75%), mean (from 8 to 16 μ m) and silt/clay ratio (from 2 to 8 μ m) indicating faster flow speeds in the moat. These differences can be interpreted in terms of enhanced hydrodynamic influence over the moat environment.

During glacial/interglacial periods. The vertical trend of the sedimentation rate versus the $\delta^{18}\text{O}$ curve from core K3 (Fig. 1A) suggests higher rates during glacial periods (MIS2, MIS4, MIS6). This probably results from an increase in terrigenous supply during periods of low sea levels. In fact, these glacial periods record high values of terrigenous elements (e.g., Ti, Zr, Si, Rb) and a low carbonate content. Additionally, there are indicators of winnowing throughout core K3, such as the presence of poorly preserved planktonic (up to 30% broken tests) and benthic foraminifera. Therefore, the increase in the coarse fraction during cold periods could be best explained by enhanced sediment supply from eolian/fluvial sources and a winnowing effect. During the cold periods (MIS2, MIS3, MIS6) and in stadial 5d in core K3, the silty facies dominates and the grain-size proxy values are higher than those of the warm periods with the exception of MIS4. During this event, anomalous paleocurrent proxy values, high clay content values and an increase in Al intensity are seen (Fig. 1B). A notable feature of paleocurrent proxies is

an increase in values at the beginning of MIS4 followed by a sharp decrease in spite of cool conditions, which is supported by the heaviest $\delta^{18}\text{O}$ values (Fig. 1A, B). The cause of the anomalous paleocurrent proxy values could be linked to the deepening of the WMDW flow axis. We point out that the deepest WMDW position coincides with an important sea level fall during MIS 4 (-120m). The migration of the flow axis towards a deeper area may imply that the area is affected by the interphase zone between two water masses, LIW and WMDW. As consequence, distinguishing the water masses present during each episode is crucial for the comprehensive interpretation of the paleocurrent proxies observed in the Djibouti Ville Drift. Finally, core K3 provides evidence of drastic acceleration and deceleration of flow speeds over the last 133kyr.

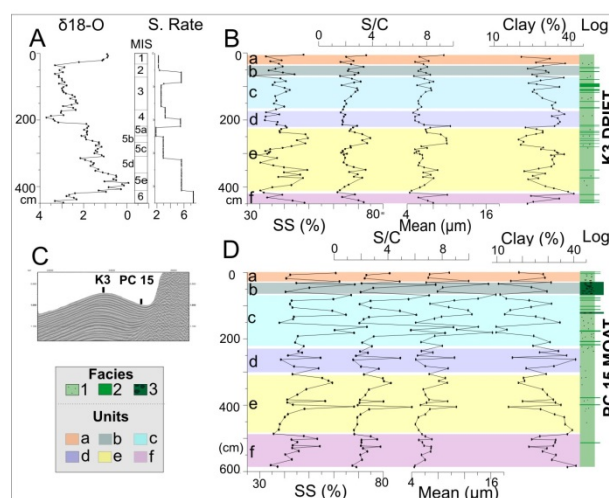


FIGURE 1. Sedimentary records of the Djibouti Ville Drift: A) $\delta^{18}\text{O}$ curve and sedimentation rate (cm.kyr^{-1}) in core K3; B) paleocurrent proxies for core K3 and log; C) Airgun seismic profile; and D) paleocurrent proxies for core PC 15 and log.

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